





\$0.4-27.5 million km^{-1}
(Linham and Green 2010)



Consequences for services



Social-Ecological System

Biophysical

Human

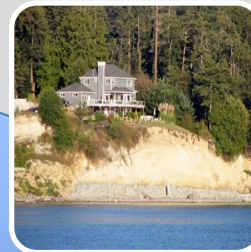
Structure &
Function



Supply



Service



Human locations &
Activities



Benefit



Social
preferences





Climate Adaptation Planning Tools

InVEST

Coastal vulnerability model

Coastal protection model

Models for co-benefits

Habitat climate adaptation tool

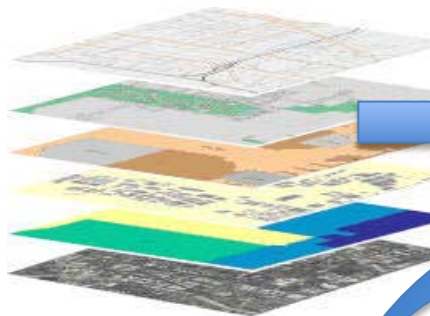
1

Define Partnerships, Roles & Objectives



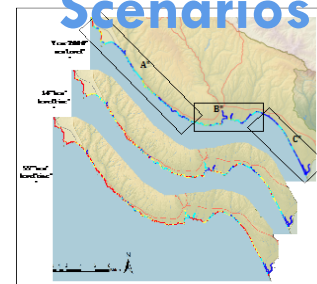
2

Compile Data



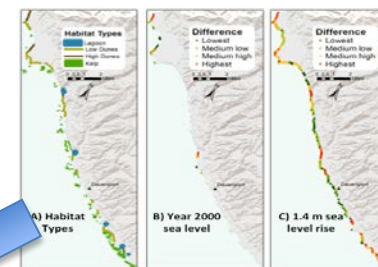
3

Generate Baseline & Scenarios



4

Assess Outcomes



Iterate & Build Capacity

6

5

Synthesize Results

7

Inform Decisions

Belize Integrated Coastal Zone Management Plan
2012
Coastal Zone Management Authority and Institute
Ministry of Forestry, Fisheries, and Sustainable Development



Promoting the Wise, Planned Use of Belize's Coastal Resources
Cite as:
Coastal Zone Management Authority and Institute (CZMAI), 2012. Belize Integrated Coastal Zone Management Plan. (CZMAI, Belize City).
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Well-being metrics



*SERVICESHED



MONEY



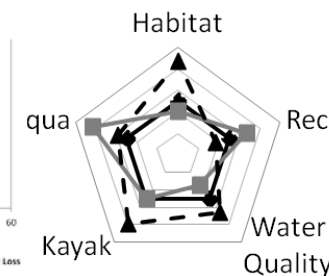
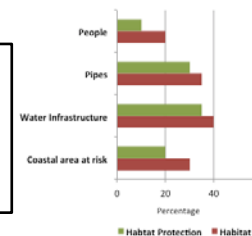
HEALTH



HAPPINESS



SECURITY





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Coastal Vulnerability

1



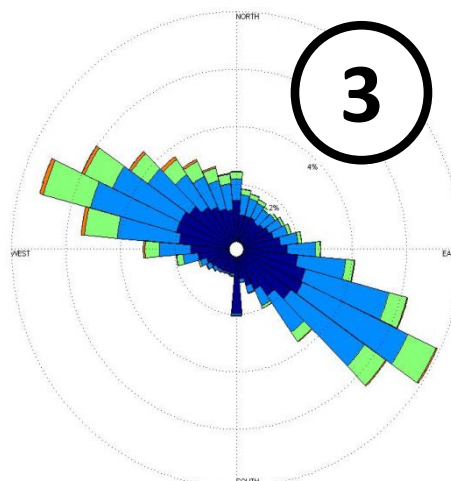
GEOMORPHOLOGY

2



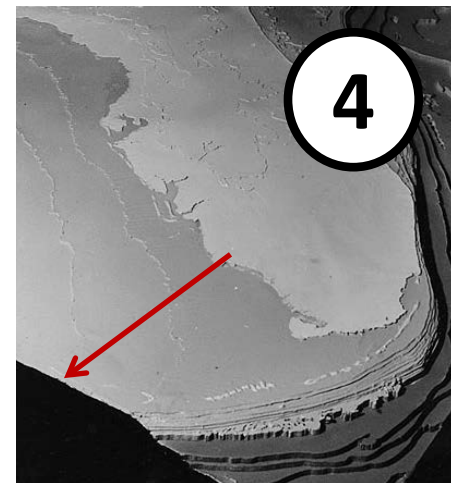
NATURAL HABITATS

3



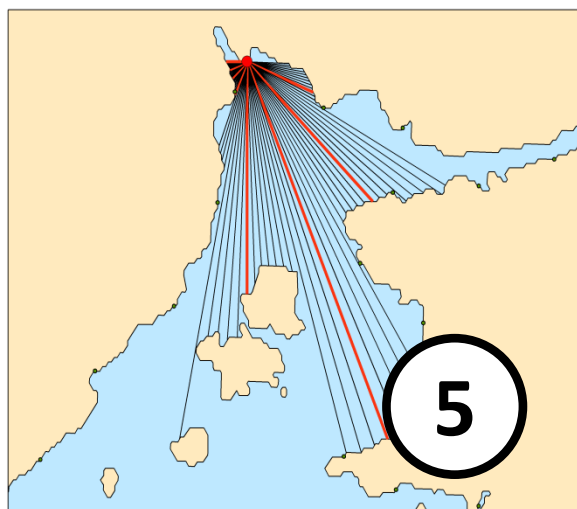
WIND EXPOSURE

4



SURGE POTENTIAL

5



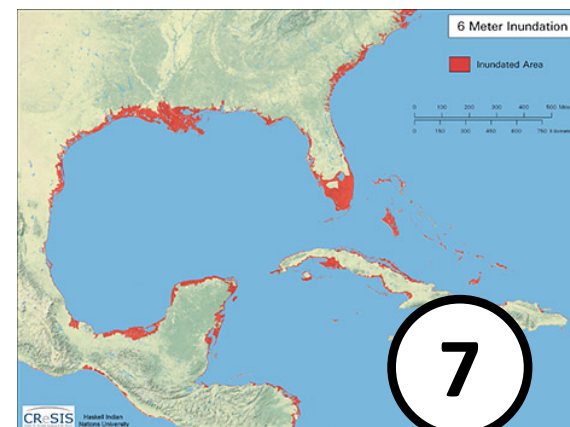
WAVE EXPOSURE

6



RELIEF

7



SEA LEVEL RISE

Coastal Vulnerability

1



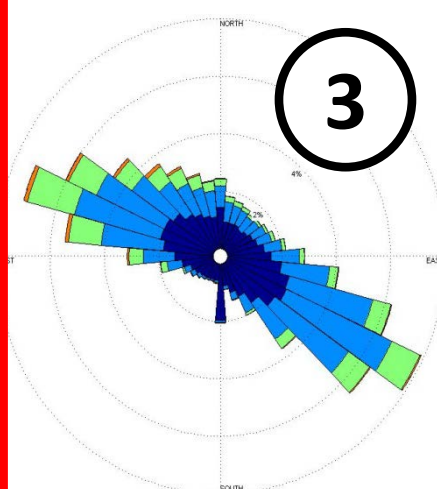
GEOMORPHOLOGY

2



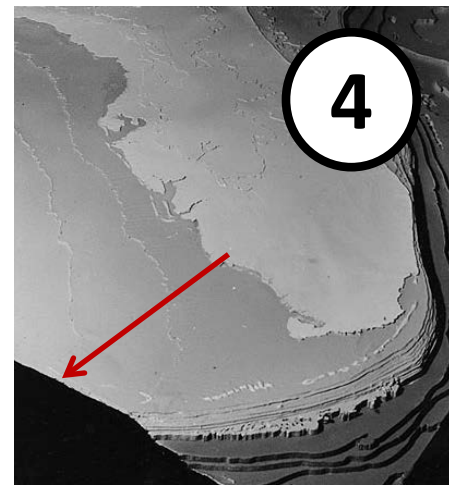
NATURAL HABITATS

3



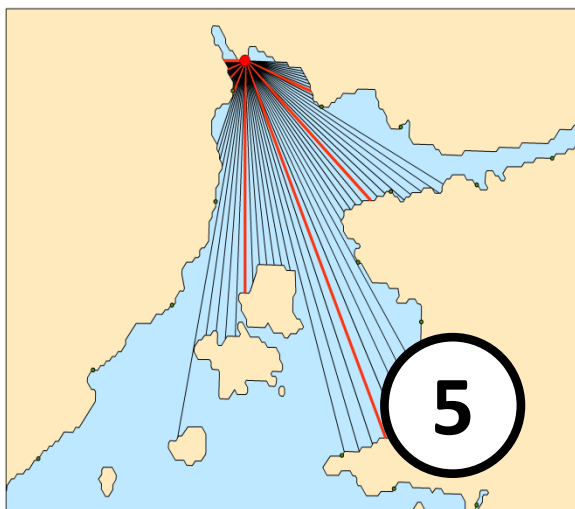
WIND EXPOSURE

4



SURGE POTENTIAL

5



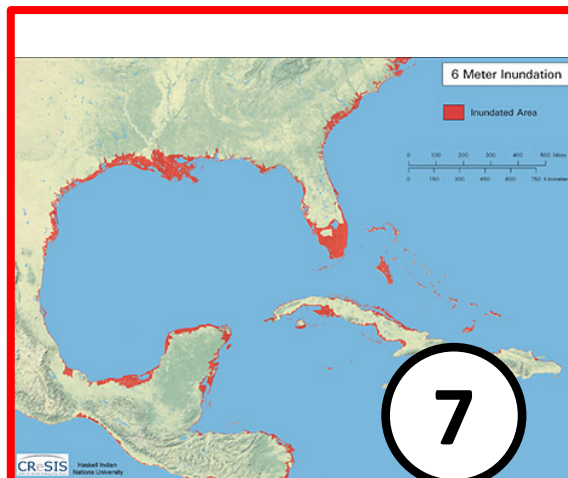
WAVE EXPOSURE

6



RELIEF

7



SEA LEVEL RISE

Coastal Vulnerability



Where and to what extent do coastal ecosystems protect:

People

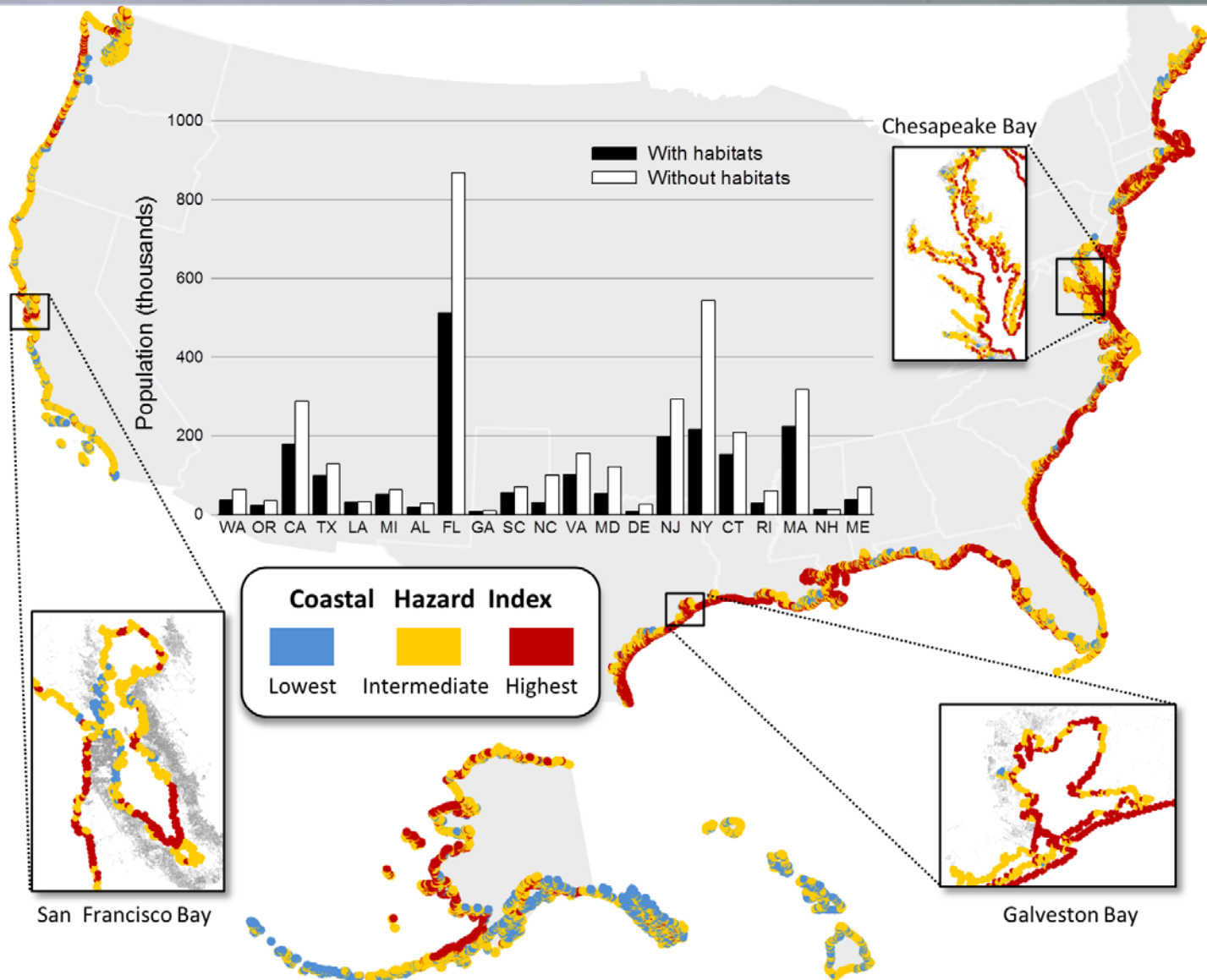
Vulnerable people and disadvantaged communities

Water Infrastructure

and...

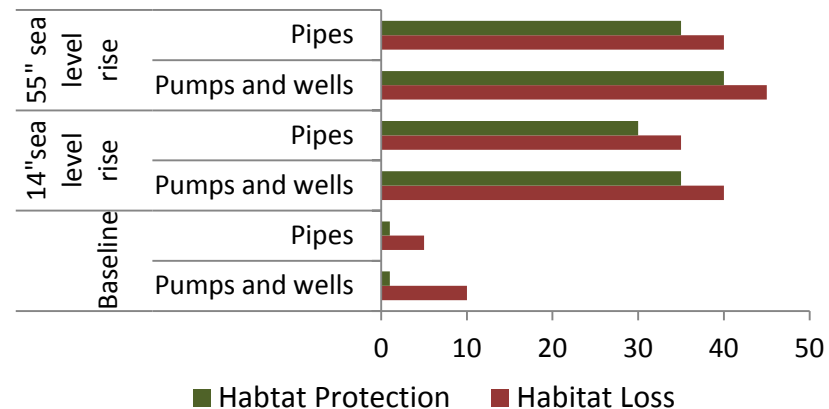
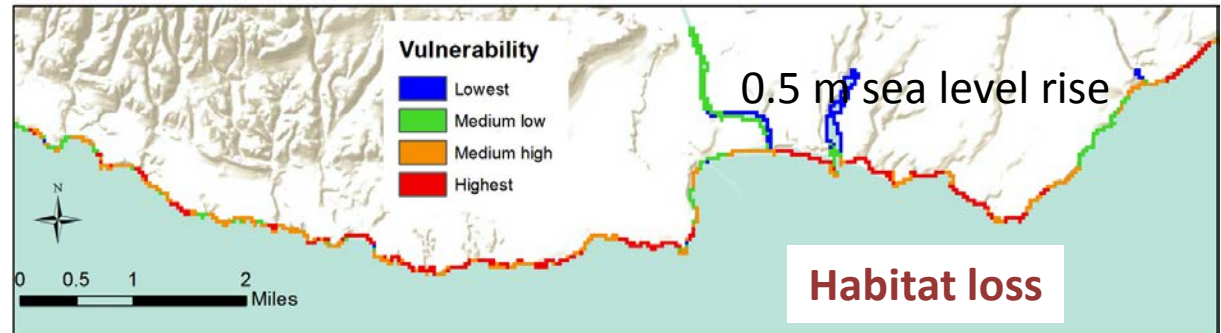
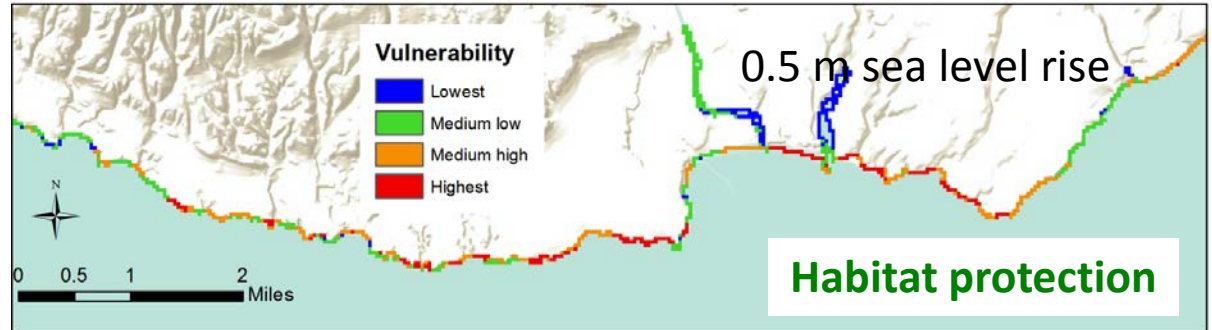


Coastal Vulnerability – US Scale



Coastal Vulnerability – County scale

Integrated Regional Water Management in California





Climate Adaptation Planning Tools

InVEST

Coastal vulnerability model

Coastal protection model

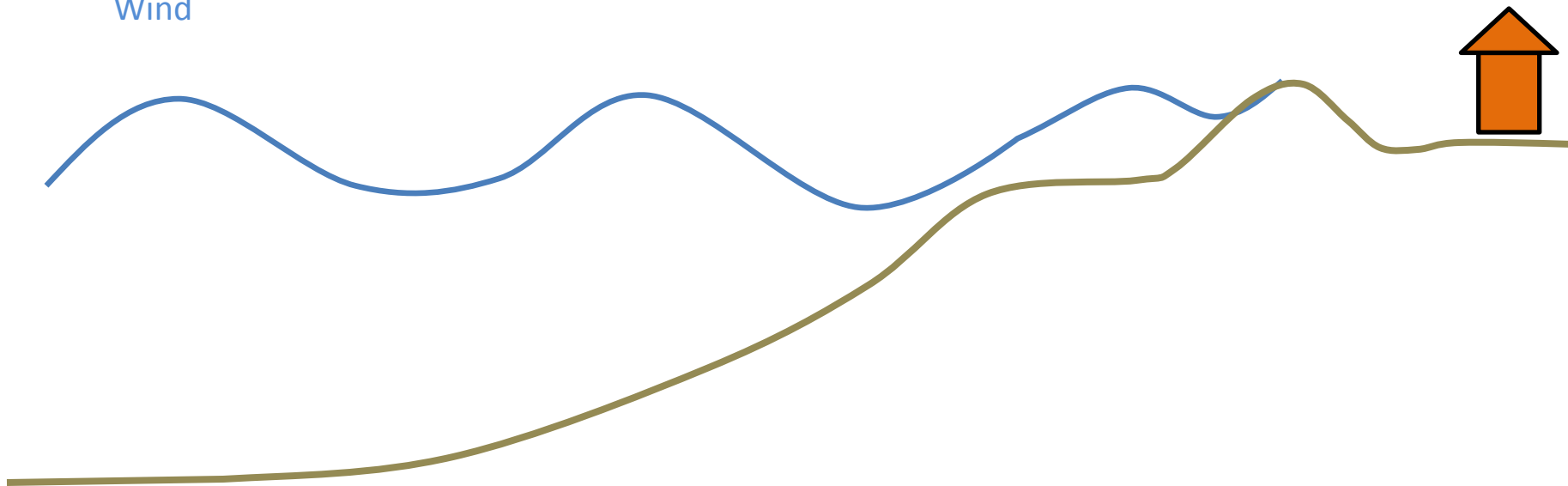
Models for co-benefits

Habitat climate adaptation tool

Coastal Protection

Forcing Conditions

Waves
Baseline tide
Long-term sea-level rise
Currents
Wind



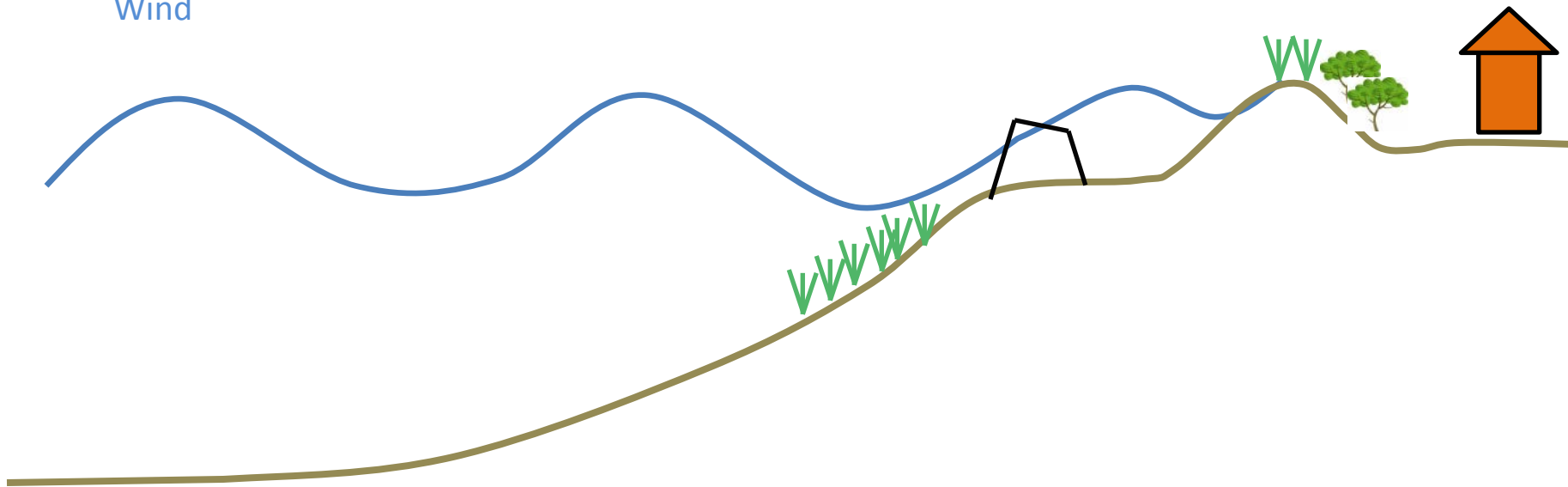
Coastal Protection

Forcing Conditions

Waves
Baseline tide
Long-term sea-level rise
Currents
Wind

Attenuation

Biogenic habitat
Abiotic morphology
'Hard' structures



Coastal Protection

Forcing Conditions

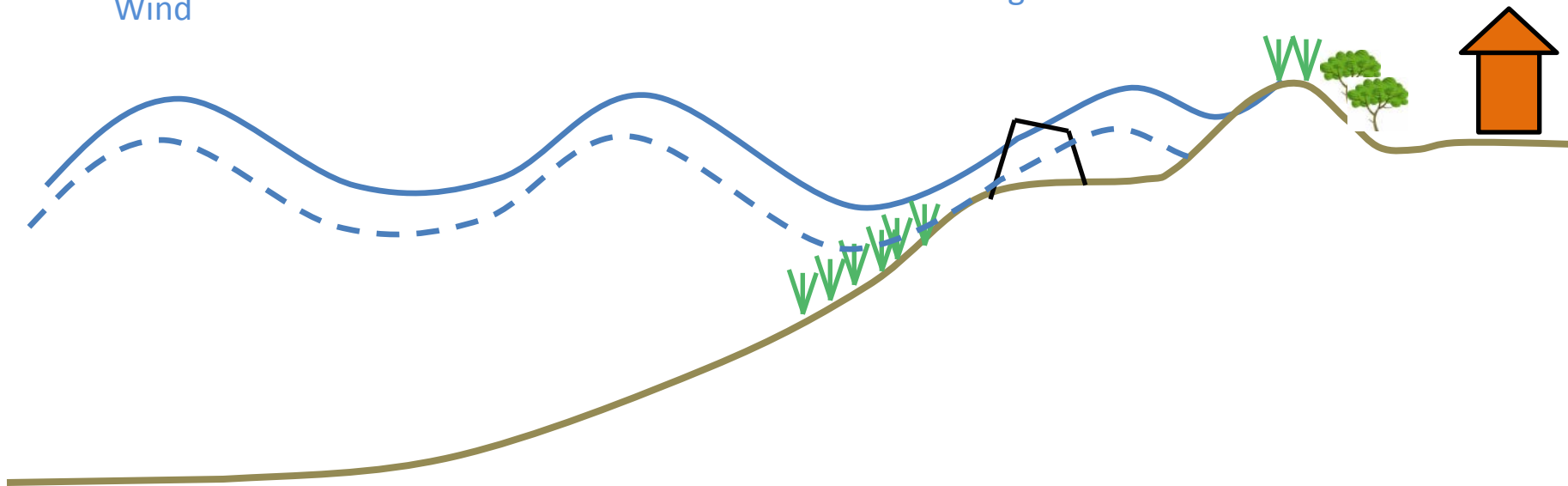
Waves
Baseline tide
Long-term sea-level rise
Currents
Wind

Attenuation

Biogenic habitat
Abiotic morphology
'Hard' structures

Hydrodynamic Output

Wave height
Mean water level
Runup
Storm surge



Coastal Protection

Forcing Conditions

Waves
Baseline tide
Long-term sea-level rise
Currents
Wind

Attenuation

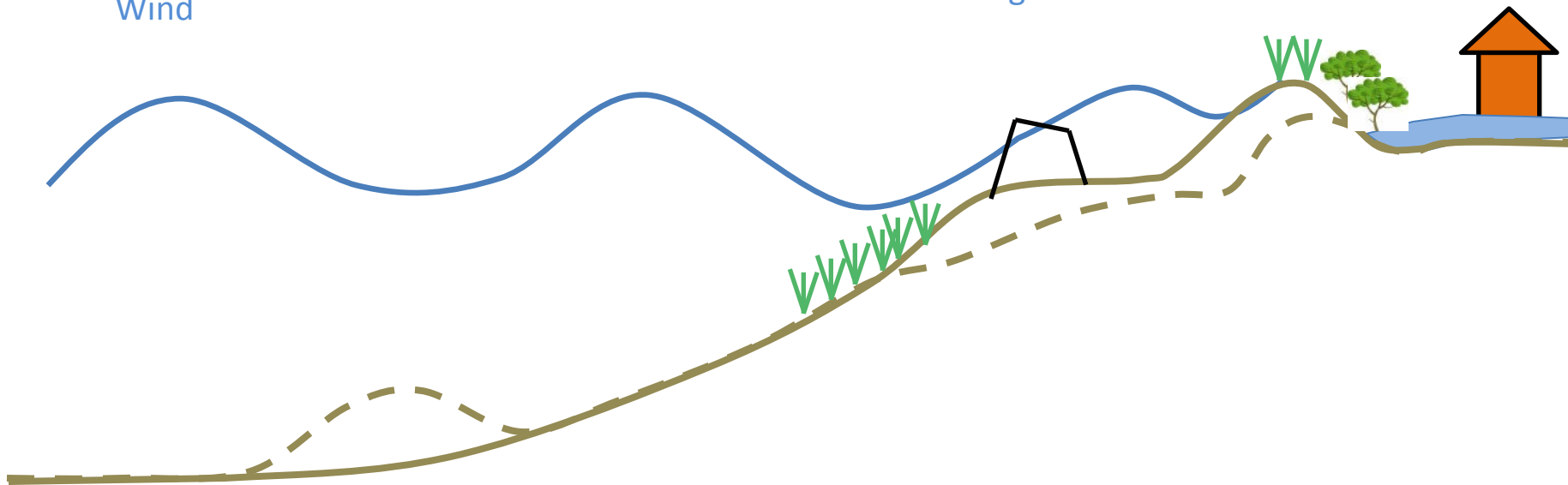
Biogenic habitat
Abiotic morphology
'Hard' structures

Hydrodynamic Output

Wave height
Mean water level
Runup
Storm surge

Erosion Flooding

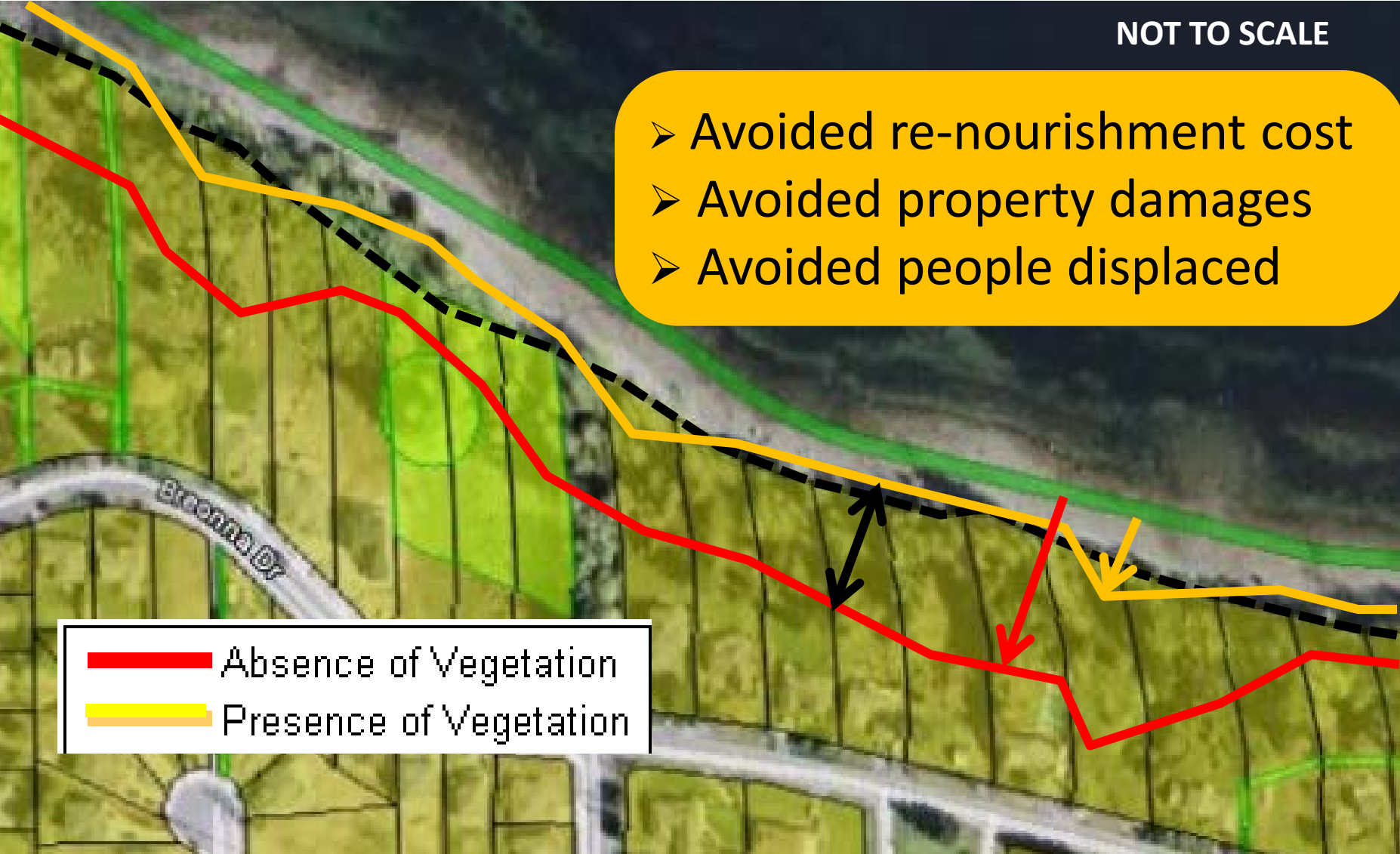
Near property and people



Coastal Protection

NOT TO SCALE

- Avoided re-nourishment cost
- Avoided property damages
- Avoided people displaced



Absence of Vegetation

Presence of Vegetation



Climate Adaptation Planning Tools

InVEST

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How might coastal development affect
Erosion/flooding from storm events?



How might coastal development affect
Erosion/flooding from storm events?
Coastal and marine recreation?
Nursery habitat for key species?
Fisheries?
Carbon sequestration?

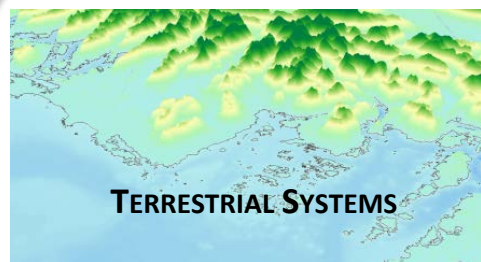


Input Data (reflect scenarios)

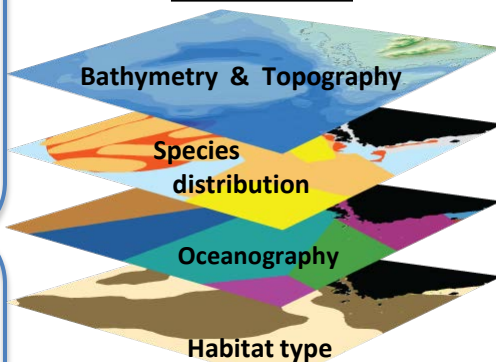
Marine InVEST Models

Model Outputs (ecosystem services & values)

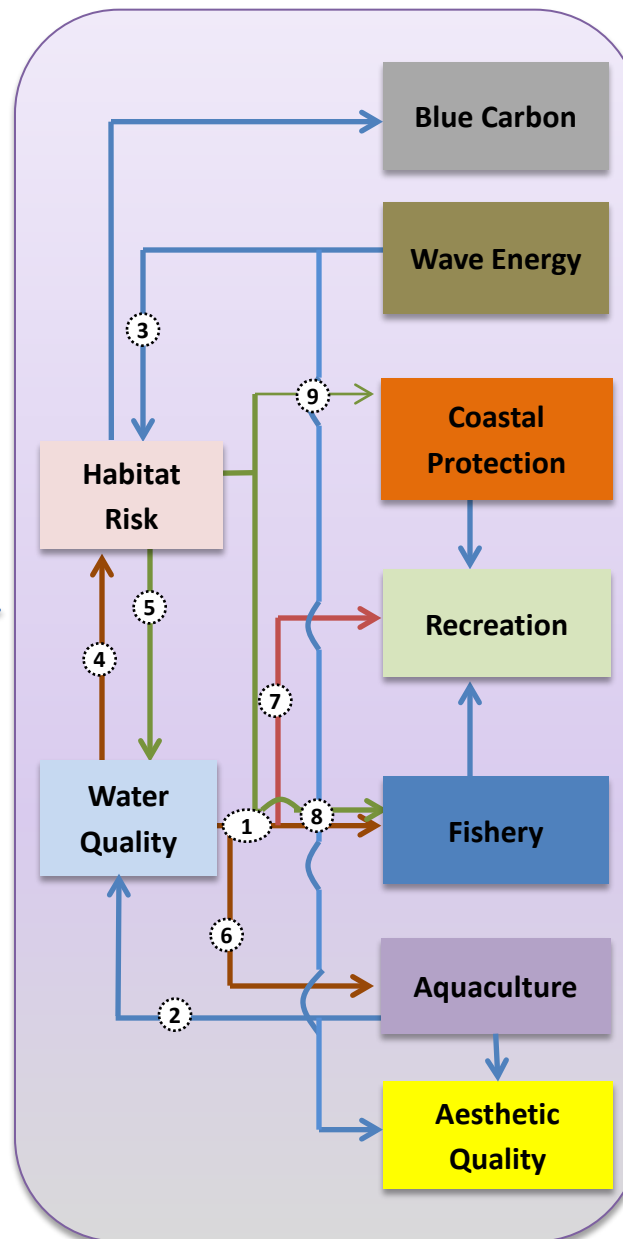
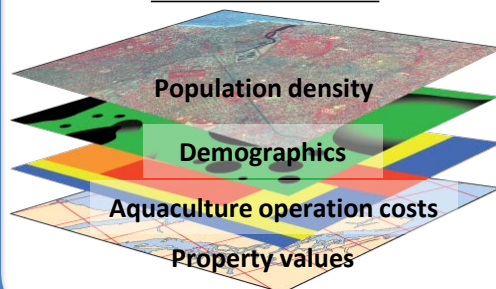
SCENARIOS



BIO-PHYSICAL



SOCIO-ECONOMIC



ECOSYSTEM SERVICES

VALUATION e.g.

Carbon Sequestered

Value of carbon sequestered

Energy Captured

Value of captured wave energy

Avoided Area Flooded/Eroded

Value of avoided damages

Visitation Rates

Expenditures due to recreation activity

Landed Biomass

Net present value of finfish and shellfish

Harvested Biomass

Guerry et al 2012

Identification and valuation of alternative adaptation options in Belize, Central America:

What are the costs and benefits of alternative climate adaptation options?

ECOSYSTEM SERVICES & VALUES SOUTH-CENTRAL PLANNING REGION

ANNUAL RETURNS (2025 – 2100)

Adaptation >>
Scenarios

NO
ACTION

INTEGRATED

REACTIVE



Climate Scenarios >>

INACTION

MITIGATION

CATCH (thsd. pounds)

19,44

24,54

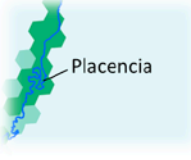
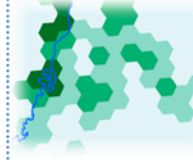
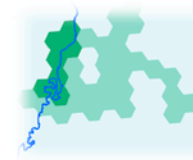
3,6

REVENUE (thsd. BZ\$)

205,470

253,576

135,310



VISTOR DAYS (# in thsd.)

441

549

368

EXPENDITURES (mil. BZ\$)

47

94

39



CARBON SEQ. (mil. tons)

3.9

4.1

3.7

VALUE (thsd. BZ\$)

-

141

-786



Climate Adaptation Planning Tools

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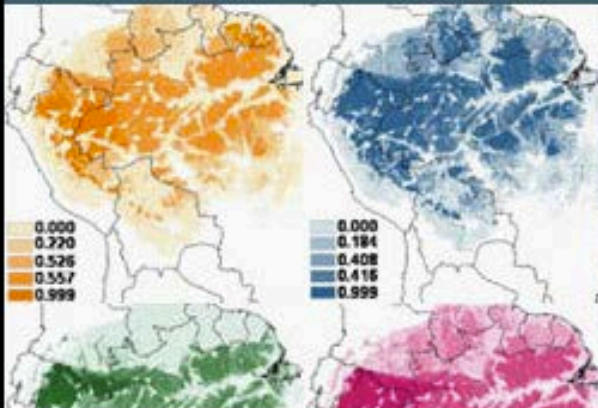
Habitat climate adaptation tool

NatCap Annual Meeting

& InVEST Training - March 13-15 - Registration now open!



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Integrated Valuation of
Environmental Services and
Tradeoffs

"Natural Capital" = Earth's lands,
waters and their biodiversity.

"Ecosystem Services" = The
stream of vital benefits flowing
from natural capital to people.

InVEST is the leading tool for
incorporating natural capital into
decisions.



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ENVIRONMENT



The Nature
Conservancy



INSTITUTE ON THE
ENVIRONMENT
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Download InVEST 2.5.3

InVEST is a family of ecosystem service evaluation tools. Historically, the Natural Capital Project developed these models in the ArcGIS computing platform. Although this allowed us to prototype tools quickly, we found a dependency on the ArcGIS framework to be a limiting factor in collaborating with a wide audience of potential users as well as a crutch in the development of advanced functionality of the InVEST toolset.

Version 2.5.3 was released on March 21, 2013 and contains both ArcGIS dependent and standalone tools. The following table illustrates which models are available in which platform.

Model	"3.0"	Standalone ArcGIS 9.3/10.0
Crop Pollination	x	x (deprecated)
Managed Timber Production	x	x
Sediment Retention	x (beta)	x
Water Purification (nutrient)	x (beta)	x
Hydropower Production	x	x
Carbon Storage and Sequestration	x	x (deprecated)
Biodiversity	x	x (deprecated)
Marine Water Quality	x	
Habitat Risk Assessment	x (alpha)	x
Overlap Analysis	x	x (deprecated)
Aesthetic Quality		x
Marine Fish Aquaculture	x	x (deprecated)
Erosion Protection		x
Coastal Vulnerability	x (alpha)	x
Wave Energy	x	x (deprecated)
Wind Energy	x	



Download
InVEST 2.5.3
47 MB



**InVEST
Documentation**

- [Individual InVEST demo datasets.](#)
- [Older InVEST versions.](#)
- [Download Water Funds Prioritization Tool](#)

InVEST

integrated valuation of
environmental services
and tradeoffs



Coastal Vulnerability

[Users Guide](#)

[Training Video](#)

Model Outputs

[Vulnerability Index](#)

[Population Raster](#)

Auxiliary Tools

[Fetch Calculator](#)

[Population Map](#)

[Generator](#)

[All InVEST Models](#)

Coastal Vulnerability Model

The InVEST Coastal Vulnerability model uses geophysical and natural habitat characteristics of coastal landscapes to compare their exposure to erosion and flooding in severe weather. When overlaid with data on coastal population density, the model's outputs can be used to identify where humans face higher risks of damage from storm waves and surge.



Learn More

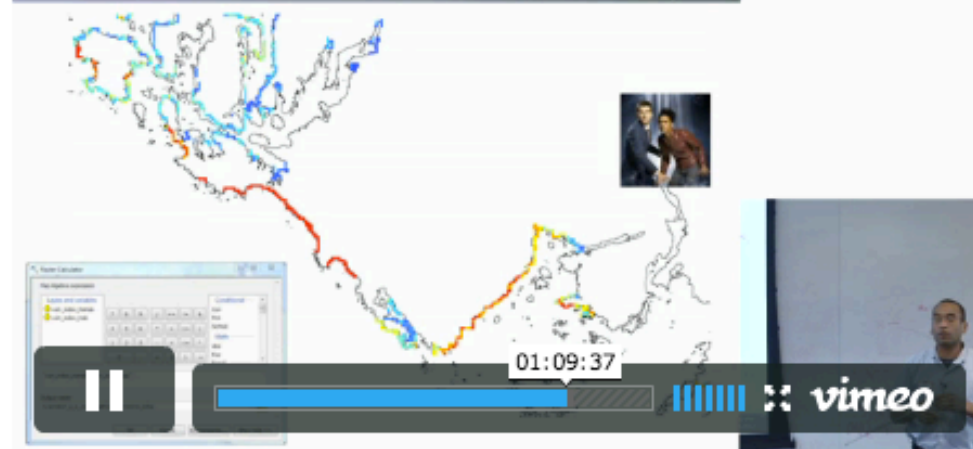
[InVEST User's Guide](#) chapter on the Coastal Vulnerability Model

[Training video](#) on the Coastal Vulnerability Model presented by Greg Guannell and Gregg Verutes, researchers at the Natural Capital Project.



User's Guide
Coastal Vulnerability

Post-Processing...

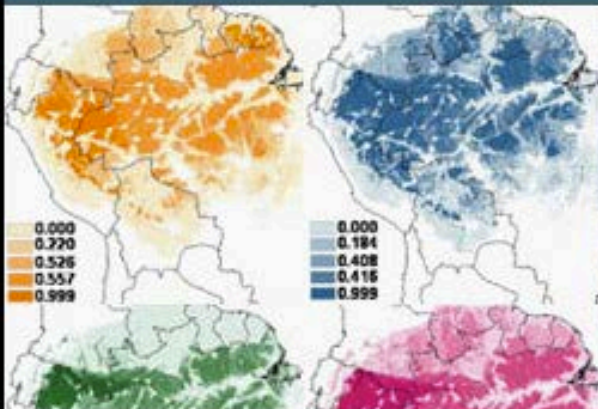


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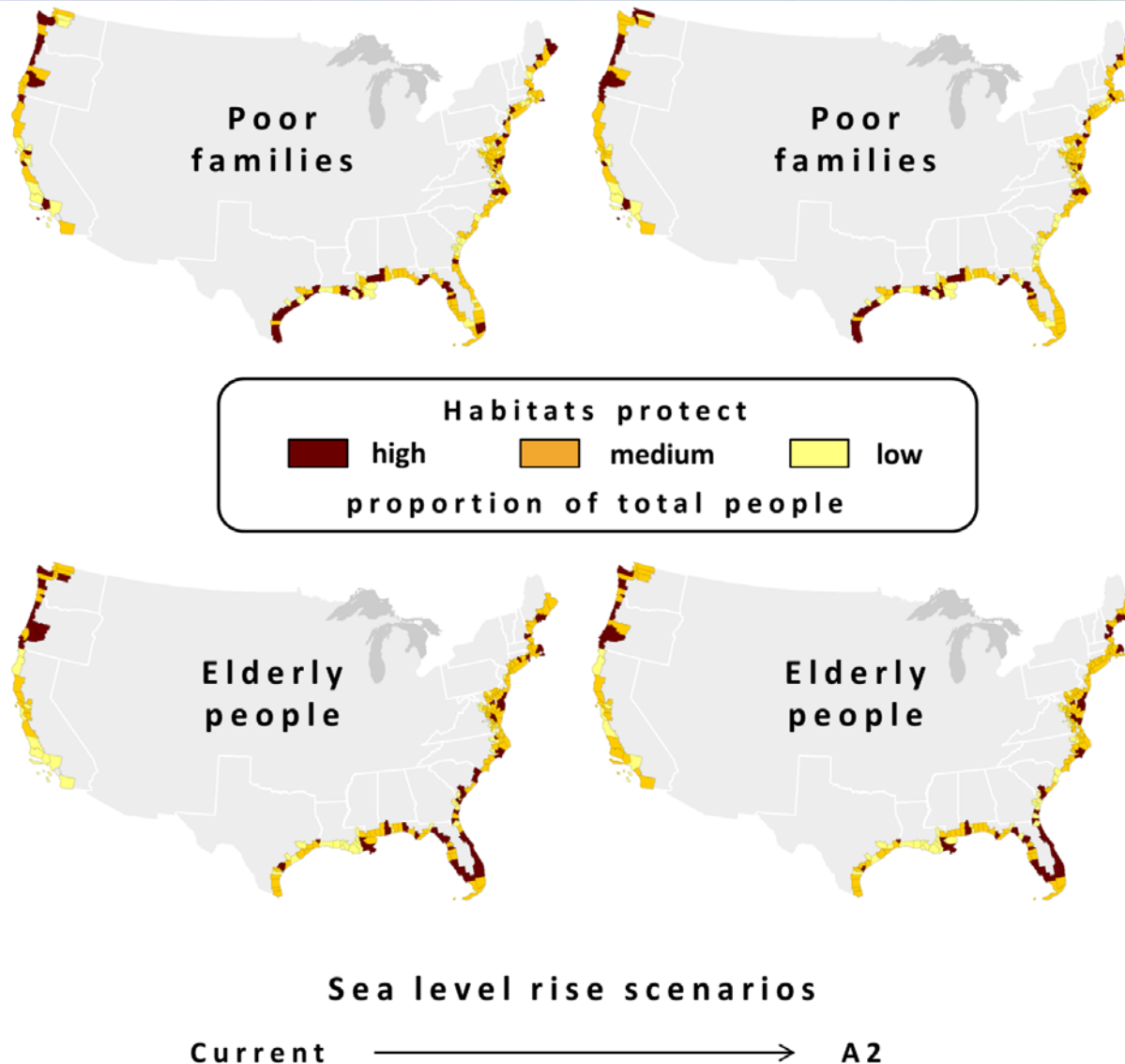
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Extras

Coastal Vulnerability - US Scale



Habitat Climate Adaptation Tool

- Identify key climate change stressors that may affect marine and coastal habitats in a particular region
- Indicate relative vulnerability of current habitats to climate-change
- Produce future habitat footprints based on climate-related changes in distribution

Tools for differing data availability

Data Heavy

Data Light

Future habitat footprint

Relative vulnerability index

Global vulnerability

- Spatially explicit
- Predicts future habitat footprint
- Requires high quality data (DEM)
- Model specific to habitat and climate stressor

- Spatially explicit (some criteria)
- Predicts vulnerability of current habitat footprint
- Does *not* produce future habitat footprint
- Method easily generalizable to multiple habitats

- Not spatially explicit
- 'high-level,' big picture tool
- Can be parameterized by the user without GIS layers
- Can qualitatively compare among regions, habitat types & climate stressors